Hydrating Californians

Lesson Description
Students will build and use a model to demonstrate the energy used to transport and purify water for consumers in California. Students will be able to explain the water-energy nexus and identify the challenges of moving water from its source to faucets.

Lesson Objective
Students will explain how water travels and define the water-energy nexus.

Lesson Topic(s)
- Water traveling
- Water-energy nexus

Suggested Preparation Time
- 10 min

Suggested Teaching Time
- 40 min

Driving Question
When we use water at home or school, where does that water come from?

Materials
Provided by The Energy Coalition
- 1 cup with one or two holes per student

Educator Gathers
- 1 ruler
- access to water
- 3 buckets each filled with water
- 3 empty buckets
- *California's Waterways* slides

Vocabulary
- aqueduct
- energy

Next Generation Science Standards

K-ESS2-2.	Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.	
Engaging in Argument from Evidence	ESS2.E: Biogeology • Plants and animals can change their environment. ESS3.C: Human Impacts on Earth Systems • Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (secondary)	Systems and System Models
K-ESS3-3.	Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.	
Obtaining, Evaluating, and Communicating Information	ESS3.C: Human Impacts on Earth Systems • Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. ETS1.B: Developing Possible Solutions • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary)	Cause and Effect
2-ESS2-1.	Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.	
Constructing Explanations and Designing Solutions	ESS2.A: Earth Materials and Systems • Wind and water can change the shape of the land. ETS1.C: Optimizing the Design Solution • Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (secondary)	Stability and Change Connections to Engineering,Technology, and Applications of Science Influence of Engineering, Technology, and Science on Society and the Natural World Connections to Nature of Science Science Addresses Questions About the Natural and Material World

2-ESS2-2.	Develop a model to represent the shapes and kinds of land and bodies of water in an area.	
Developing and Using Models	ESS2.B: Plate Tectonics and Large-Scale System Interactions • Maps show where things are located. One can map the shapes and kinds of land and water in any area.	Patterns

California Environmental Principles and Concepts

Principle 1 - People Depend on Natural Systems
A. The goods produced by natural systems are essential to human life and to the functioning of our economies and cultures.
B. The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.
C. That the quality, quantity, and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.
Principle 2 - People Influence Natural Systems
A. Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.
B. Methods used to extract, harvest, transport, and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.
C. The expansion and operation of human communities influence the geographic extent, composition, biological diversity, and viability of natural systems.
D. The legal, economic, and political systems that govern the use and management of natural systems directly influence the geographic extent, composition, biological diversity, and viability of natural systems.
Principle 3 - Natural Systems Change in Ways that People Benefit From and Can Influence
A. Natural systems proceed through cycles and processes that are required for their functioning.
B. Human practices depend upon and benefit from the cycles and processes that operate within natural systems.
C. Human practices can alter the cycles and processes that operate within natural systems.

Principle 4 - There are no Permanent or Impermeable Boundaries that Prevent Matter from Flowing Between Systems
A. The effects of human activities on natural systems are directly related to the quantities of resources consumed and to the quantity and characteristics of the resulting byproducts.
B. The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.
C. The capacity of natural systems to adjust to human-caused alterations depends on the nature of the system as well as the scope, scale, and duration of the activity, and the nature of its byproducts.
Principle 5 - Decisions Affecting Resources and Natural Systems are Complex and Involve Many Factors
A. There is a spectrum of what is considered in making decisions about resources and natural systems and how those factors influence decisions.
B. The process of making decisions about resources and natural systems, and how the assessment of social, economic, political, and environmental factors has changed over time.

Watch or read it!

- Follow us on social media:
  - Pinterest: @energyiseverything
  - Instagram: @energy_is_everything
  - Facebook: @EnergyiEverything
  - YouTube: Energy is Everything

Content Background for the Educator

Some parts of California receive much more rain than others. Northern California may receive more than 60-inches of rain each year, while parts of Southern California may receive fewer than 3-inches! For all residents to get water, pumps move water between various parts of the state. **Energy** powers many pumps that move water through pipes, **aqueducts**, and human-made water channels. Population growth drives demand for both water and energy. While this demand increases, the supply of water does not; this adds stress to an already strained electricity and water delivery system. When electric infrastructure fails, the water system fails, threatening public health and safety. This interconnected relationship between water and energy is known as the water-energy nexus.

Introduce

If this is the first lesson taught, ensure completion of the **Pre-Teaching Survey** *to ensure a complete Student Learning Report.*

Ask students, "Why is water so important to our lives? In what ways do you use water every day?" As water is essential to survival, humans must make sure that clean water is available no matter where they live. Tell students that they will demonstrate Energy used to move water. Have students identify on a map the location of your region in the state. As a class, find out how much rain (precipitation) the region gets each year. Also, identify which areas on the map receive the least amount of rain each year?

Select three volunteers to form a line by holding hands. This line of students represents the water. The line's leader represents the energy (electricity) used to bring that water to areas in need (you). Ask students, "What would be the best way to move water from one place to another?" Solicit responses. Say, "A pumping system uses an incredible amount of energy to pull and push water to the needed area." Gently pull the person's hand next to you and take a few steps to the side. Explain that different degrees of pressure affect how water travels:

- Too weak (pull meekly) – water does not go
- Too strong (pull harder) – water is hard to control

Discuss the *California's Waterways* slides. Use the maps to discuss topography (the arrangement of the natural and artificial physical features of an area), precipitation amounts in California, and water sources. Describe water's pathway through hills and mountains on its way to the consumer. Ask students, "Does it require more or less energy to go uphill?" Roleplay with students by having them all stand-up and hold hands. Explain how long it takes water to travel by timing how long it takes a hand squeeze to make it from one side of the class to the other. Say, "When I say go, I will start the timer and squeeze the person's hand next to me. They will then squeeze the next person's hand and so on. We will do this a few times to see if we can have our water travel as fast as possible." Remind students that water travels up hills and down mountainsides. Have a few students sit on the floor, and some raise their hands high to demonstrate variations in topography.

Investigate

Move students to an outdoor space that can get wet. Place three buckets on the floor and designate them as:

- bucket 1 - California Aqueduct
- bucket 2 - Colorado River Aqueduct
- bucket 3 - Los Angeles Aqueduct

Organize students into three different teams by counting them off one-two-three. Have all the number one's stand behind bucket 1, all the number two's and three's do the same. Each team forms a line. The start of the line will be the influent (where water flows in), and the end of the line will be the effluent (where water flows out). Distribute a cup with a hole to each student. Explain that they represent leaks in the pipes.

Have each line leader (aka "water source") dip a cup with holes in the water, and then transfer the water into the next person's cup without spilling any; the recipient will then pour the water into the next person's cup; and so on. This pattern will continue down the line. The last person is the water consumer who will carefully pour his/her cup into the basin. After each group gets the hang of the process, empty the effluent buckets into the influent buckets. Each bucket should contain an equal amount of water.

Explain to students that they are going to "race" to transport water. The object of the race is to see which group can waste the least amount of water as they transport it from the source to the consumer. By moving slowly, methodically, and conserving energy, students will find they end up with more water in their effluent bucket at the end of the line! After each team has finished transferring their water to the effluent bucket, use a ruler to measure and see who conserved the most water and energy, thereby winning the race!

Wrap-up

Students will realize how much energy and teamwork is required to move a little bit of water from point A to point B to understand just how much energy it takes to move billions of gallons from one region to another. Have students brainstorm ways to save water and energy at home.

Community Connection

Clean water is a necessary part of a community. Ask students, "If you had to talk to community members about their water, what would you say? How would you encourage community members to reduce their water use?" Have students practice what they might say. Challenge them to tell friends, family, and community members when they go home. Tell students to keep the following things in mind:

- How can you get people to care about their water use?
- What is an action that you can ask people to take?
- What is the best tone to take when talking to people about clean drinking water?

Connect it

Have students take home the *My Future Energy Career* handout and ask an adult to read the career description to them. Students can complete the maze.

Remember to complete a **Lesson Reflection and Feedback** *after completing the lesson to ensure a complete Student Learning Report.*

If this is the last lesson taught, ensure completion of the **Post-Teaching Survey and Program Evaluation** *to ensure a complete Student Learning Report.*

Glossary

Word	Part of Speech	Definition
aqueduct	noun	A channel used for moving water.
energy	noun	The ability to do work.

My Future Energy Career

Send a Time Capsule Postcard to Yourself!

Have a conversation between you and your future self!

- What would you want to tell your future self about being green?
- What advice would you give yourself about how to pursue a STEM career?

Put it into Practice

Cut out a postcard-sized rectangle from recycled cardboard (you can use a cereal box or box that a package came in). Complete the postcard with the careers you'd like to have when you are older. Include some advice on what you think your future self should be doing. Now is a great time to give yourself a pep talk about what green career path to follow.

Add your name and mailing address to the right side and turn your completed postcard into your teacher and she will send them to you in a few years!